



Course Title: **Compilers and Languages**
(First term)

Course Code: CCE3113 3rd year
Allowed time: 15 minutes

Quiz2

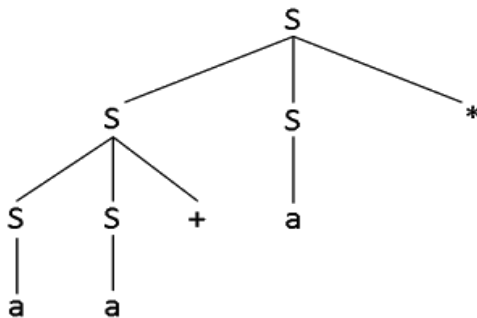
1 Consider the context free grammar

$S \rightarrow SS+ \mid SS* \mid a$

a) Show how the string $aa+a^*$ can be generated by this grammar.

$S \rightarrow SS^*$
 $\rightarrow SS+S^*$
 $\rightarrow aS+S^*$
 $\rightarrow aa+S^*$
 $\rightarrow aa+a^*$

b) Construct a parse tree for this string.



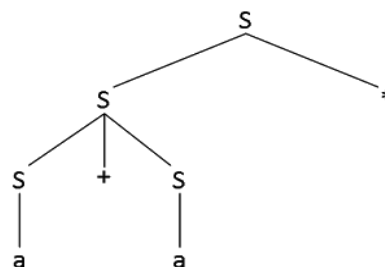
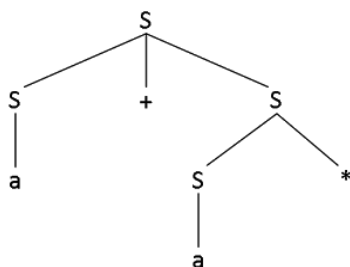
c) What language is generated by this grammar? Justify your answer.

This grammar generates a language that consists of any possible arithmetic operations involving **a** with the use of only the + and * operations and the postfix notation. The only non-terminal symbol in the grammar is **S** and it replaces all occurrences of **S**, leaving only a statement consisting of a series of **a**'s and the + and * operations.

2. Which of the grammars are ambiguous?

- a) $S \rightarrow 0S1 \mid 01$
- b) $S \rightarrow +SS \mid -SS \mid a$
- c) $S \rightarrow S(S)S \mid \epsilon$
- d) $S \rightarrow aSbS \mid bSaS \mid \epsilon$
- e) $S \rightarrow a \mid S+S \mid SS \mid S^* \mid (S)$

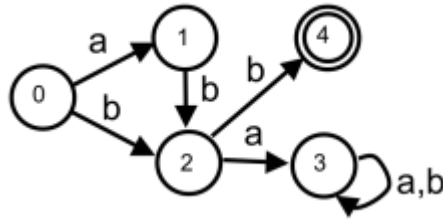
Answer: Only the grammar in Letter **e** is ambiguous. The string $a+a^*$ can be parsed in more than one way:



3. Consider the alphabet $\Sigma = \{a; b\}$. Define the shortest, regular expression that generates strings over Σ that contain exactly one “a” and at least one “b”.

$$R = b^*(ab|ba)b^*$$

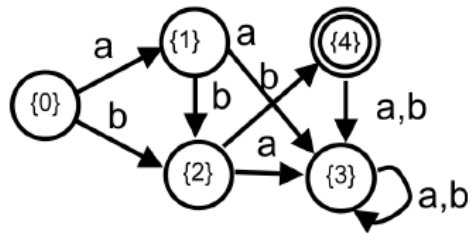
4. Given the Finite Automaton below with initial state 0 and alphabet $\{a,b\}$ answer the following questions:



- (a) Why is this FA a Non-Deterministic Finite Automaton (NFA)?
- (b) Convert this NFA to a DFA using the closure computation.
- (c) What is the Regular Expression matched by this NFA?

The answer

- (a) This FA is already a DFA, as the only transitions that are missing all go to the trap state 3.
- (b) The subset construction, which in this case yields the same original DFA on the left where we have noted the subset each state stands for.



- (c) The regular expression can be denoted by $(a|ε)bb$.

Dr. Sherin El Gokhy
Best wishes